ICA 2013 Montreal
Montreal, Canada
2 - 7 June 2013

Noise
Session 4pNSa: Effects of Noise on Human Performance and Comfort II

4pNSa6. The teachers perspective on noise in the classroom
Ana Jaramillo*, Michael Ermann and Patrick Miller

*Corresponding author's address: School of Architecture + Design, Virginia Tech, Blacksburg, VA 24060, anaja@vt.edu

A survey was sent to 3rd grade teachers in Orange County, FL to find out about their noise awareness and coping strategies. Results of the survey were also correlated to mechanical system type and achievement data. Preliminary analyses show very little awareness on mechanical noise by teachers but a good range of coping strategies when noise sources are present (mostly activity noise). The survey also helped to better understand the classroom environment. For example, most classrooms have a frequent use of computers or projectors and a few schools are still open-plan. These facts create new questions about noise in the classroom that need to be addressed in further studies.

Published by the Acoustical Society of America through the American Institute of Physics
INTRODUCTION

Studies suggest that the physical classroom environment—views, lighting, daylighting, air quality, overcrowding, thermal comfort, and furnishings—meaningfully impacts student performance (Earthman, 2002; Heschong, 1999, 2003; Jacobs, 2009). Specific to acoustics, at least 13 studies over 34 years have linked the aural environment to student cognition, concentration, and achievement (as well as teacher fatigue) (Bronzaft & McCarthy, 1975; Dockrell & Shield, 2005; Hygge, Evans & Bullinger, 2002; Jaramillo & Ermann, 2012; Maroko & Shwe, 2005; Nelson & Soli, 2000; Ronsse & Wang, 2009; Shield & Dockrell, 2007; Siebein & Likendey, 2004; Stansfeld et al., 2005; Vilatarsana, 2004; Zentall & Shaw, 1980; Zusman, 2007). The effect is most pronounced on the youngest students, non-native English speakers, and those with hearing difficulty (including children with colds and ear infections) (Bradley, 2002; Elliot, 1982). Young brains do not properly “fill-in-the-gaps” when they’ve missed a word in a sentence, leaving them deprived of the meaning of the sentence and absent ownership of school content. And while poor room acoustics is a common problem in classrooms, it is background noise that typically deviates farther from the ideal (Bradley, 2002).

Researchers have documented mechanical heating and cooling equipment noise as the prime contributor to classroom noise, (Siebein et al., 2000; Nelson et al., 2005) and the type of cooling system determines, in large part, the level of the mechanical noise in the classroom (in temperate and warm climates). Mechanical cooling noise sources may be categorized into one of three classifications: (1) remote fan and remote compressor, (2) local fan and remote compressor, and (3) local fan and local compressor. Of the three types, the quietest typology involves air systems with distant, centralized, air handling units (AHUs) and remote chillers and cooling towers. Next loudest, AHUs and fan-coil units that serve only one space may feature remote chiller equipment but fans that are either located in the room being served, or just adjacent to it in a ceiling plenum, over a corridor, or in a closet. Finally, the loudest system typology, through-the-wall units, features both compressors and fans located in the rooms served. These are sometimes referred to as unitary systems, direct expansion systems, or DX systems, and are colloquially termed “window units” (Siebein et al., 2000).

The teacher survey results presented here complements a prior study by the same authors (Jaramillo & Ermann, 2012). That investigation surveyed 73 of the 129 elementary schools in Orange County, Florida school district and their mechanical systems were analyzed statistically against third grade school achievement test scores over eight years. The analysis found, not surprisingly, that test scores were overwhelmingly influenced by the socio-economic profile of the school’s students; schools populated by higher-income children out-performed those populated by poorer children. But when the data were culled into three groups, each corresponding to a different type of mechanical system, the results suggested that, for a given student income level, achievement scores drop in schools with the noisiest systems (Jaramillo & Ermann, 2012). What do the teachers in that school district think about noise in their classrooms?

METHODS

Orange County, FL is one of the largest school districts in the US, providing a large sample size. Out of the 129 elementary schools in the district 73 answered an HVAC survey (56% response rate) to determine cooling system type. The warm southern US climate necessitates air conditioning almost year-round, so heating systems—which may be of a different type and noise level than cooling systems—don’t cloud data. A survey to measure experiences with, and attitudes toward, noise was then distributed by email to 396 third grade teachers at those schools and 87 responded (22% response rate).

Those schools found to have rooftop package units and those schools with recent HVAC system renovations were eliminated from the dataset, as were those found to be near busy highways or airports. The 56% of schools that responded to the first survey were mapped to tease out patterns indicative of confounding variables and spurious relationships. No patterns were evident. Teacher quality, teacher education, teacher experience, school minority rate, gender balance, percentage of non-native speakers, and average class size were either tabulated in the data or sufficiently randomized.
The Florida Comprehensive Assessment Test (FCAT) is the state-wide achievement test used for this study. Standardized test scores, though limited in their assessment of absolute learning, are a proven tool to compare composite achievement between schools or districts. FCAT scores—whole-school data—were obtained from online published public records. Eight years of data were collected, from 2003 to 2010, in the third grade for all schools in the district. FCATs divide achievement into 5 levels, so this study uses the “percentage of students scoring in the top level” variable to represent achievement.

FIGURE 1.

Student achievement by mechanical system type and socioeconomic level (in black) and speech intelligibility by mechanical system type (in gray).

Figure 1 overlays two studies—The antecedent for the one published here, that illustrates a sharp drop in student achievement in schools cooling with both fan and compressor exposed to the classroom (Jaramillo & Ermann, 2012), and another one that illustrates a sharp drop in speech intelligibility associated with that same type of mechanical system, the fan and compressor exposed to the classroom (Siebein et al., 2000). The empirical data tracks closely with the theory because speech intelligibility in noisy conditions evaporates suddenly when the background levels approach, and then surpass, the speech level.
DATA

1. How noisy is your classroom without students?

![Bar chart showing perceived noisiness by HVAC type.](image)

**FIGURE 2.** Perceived noisiness by HVAC type.

2. How long have you been teaching at the current school?

![Bar chart showing years of teaching at the current school.](image)

**FIGURE 3.** Years of teaching at the current school.

Though previous studies suggest adaptation should occur (Cohen, et al., 1981; Grebennikov, 2006), no significant relationship between the time spent at a particular school and noise perception was found.

3. Do you often use computers or projectors in the classroom?

![Pie chart showing percentage of teachers who use computers or projectors often in the classroom.](image)

**FIGURE 4.** Percentage of teachers who use computers or projectors often in the classroom.
4. Are there full floor-to-ceiling walls separating your classroom from adjacent rooms?

![Chart showing full wall to ceiling walls](image1.png)

**FIGURE 5.** a) Loudest noise sources as perceived by teacher in classrooms with full floor to ceiling walls. b) Loudest noise sources as perceived by teacher in open-plan classrooms.

5. What would you say is the loudest source of background noise in your classroom?

![Mechanical noise chart](image2.png)

**FIGURE 6.** Loudest noise source by HVAC type and perceived noisiness.

6. How often does noise from the heating and air conditioning system prevent students from hearing what you have to say (or require you to repeat yourself)?

![Noise prevention chart](image3.png)

**FIGURE 7.** How often noise prevents communication from the teacher to the students in a classroom by HVAC type.
7. How often does noise from the heating and air-conditioning system prevent you from hearing what your students have to say (or requires them to repeat themselves)?

FIGURE 8. How often noise prevents communication from the teacher to the students in a classroom by HVAC type.

8. What makes air-conditioning noise interfere with classroom activities?

FIGURE 9. Reasons for HVAC noise to interfere with class

9. If your classroom is noisy, do you adjust your teaching strategies to compensate?

FIGURE 10. Strategies used by teachers to compensate for background noise.
10. How important do you think it is to reduce the background noise in your classroom?

FIGURE 11. Importance given by teachers to the reduction of background noise in the classroom.

11. Do you think noise in the classroom affects learning? How so?

When asked this open-ended question, respondents volunteered the following issues, grouped into categories populated with example quotations.

*Noise Impairs communication (12 responses), for example:*
“Background noise interferes with the students’ and teachers’ ability to hear each other clearly.”
“. . . Students have difficulty hearing other students with quiet voices”
“. . . if students can’t hear instruction or each other, learning is impacted greatly”

*Noise impairs concentration (25 responses), for example:*
“. . . It can cause kids to stare, not listen, daydream, or even put them to sleep.”
“. . . I personally am very sensitive to background noise, so I can imagine that there are at least some students who have a hard time concentrating and paying attention when there is background noise in the classroom.”
“. . . The turning on and off made it nosier in the classroom and harder for kids to focus on me at times”

*Noise impedes learning in children with special needs (4 responses), for example:*
“It triggers a meltdown in my autistic student.”
“. . . many children are sensitive to noise and any extra noise is a distraction. Also, with the large number of children who suffer from periodic, temporary hearing loss due to ear infections, extra noise in the classroom prevents them from hearing instruction.”
“For ADD and ADHD children, noise in the classroom would be a nightmare, as well as for the ESL students.”

*Miscellaneous design issues (3 responses), for example:*
“Our classrooms are open to three other rooms through a hallway without doors. About twice each week I have to stop and redirect my students to our task when another classroom is doing something different.”
“Our classrooms are built with audio enhancement systems. Noise is not an issue in my classroom.”

*Mechanical noise not particularly important to address (18 responses), for example:*
“Loud noises do affect learning but small noises like a computer or an AC do not. . . children need to be taught that that is life. There are people and noises that are all around us that we may not like but we have to learn to deal with it and do our jobs.”
“I think that the absence of background noise is distracting to the students. They live in a world where there is always noise—silence is unusual for them. I often play music while the students are working to enhance their performance.”
“. . . noise in isolation becomes a greater problem versus noise that is constant, like a child who snorts or sniffs through a test or the noise of a random pencil sharpener. . . constant noise often becomes white noise and you don’t end up hearing it. . . like a window unit air conditioner . . . sometimes it is a comfort.”
12. Do you ever talk to your principal or administrator about noise from heating and air conditioning system?

The great majority of responses suggested that noise is either not important enough or appropriate to bring up with school administrators, and for the very few cases where it was brought up, it seems little was done to address noise (3 responses). For example:

“The principal is very supportive, but she can’t do anything about it.”

“I spoke to the office and a work order was put in, but it still does it. The teacher before me also complained and it never got repaired.”

![Figure 12. Student achievement by HVAC type and perceived noisiness.](image)

**DISCUSSION AND CONCLUSION**

Even when prompted with opportunities to evaluate noise, teachers in the survey were often unconcerned with their classroom cooling system noise, and when asked the source of bothersome noise, teachers were likely to identify other students (in hallways, adjacent classrooms, and their classrooms) as the culprits, rather than fixed sources like mechanical equipment. Only one study participant out of 87 labeled his room as “very noisy” without students, and only three out of 87 labeled their rooms “noisy” without students. This was in stark contrast to this study’s forerunner, which suggested student achievement drop-off in the schools with the noisiest types of systems. This suggests that acoustics researchers judge classrooms to be noisy at a far higher rate than the sample of teachers surveyed in this analysis. Relative to the first study, a disproportionate number of responders in this study came from schools with the quietest types of systems (remote fan and remote compressor), which may explain the inconsistency. While overall teachers judged their empty classrooms to be quiet, those in schools with noisier cooling systems types were more likely to think their classrooms noisy.

Few (10%) respondents reported partial-height walls, the kind that separate classrooms from one another visually, but not aurally. Nearly all teachers surveyed use classroom projectors regularly, prompting a need for more study in classroom projector acoustical impact. Because experience suggests that some projectors are far noisier than others, perhaps future classroom design standards should adopt limits to projector noise.
ACKNOWLEDGMENTS

We would like to thank...

All 3rd grade teachers in Orange County, FL who answered the survey to the best of their knowledge, helping us shed some light over this issue from their perspective

Facilities managers who provided information about the type of HVAC at each school.

Virginia Tech’s Laboratory for Interdisciplinary Statistical Analysis (LISA) consultants for their advice.

Nicky Nanji for illustration (Figure 1).

This study was supported by the Incentive Fund Award from the Architectural Research Centers Consortium (ARCC).

REFERENCES


